

# BUREAU INTERNATIONAL DES POIDS ET MESURES

## Comité Consultatif pour les Rayonnements Ionisants

### Section I (X- and $\gamma$ -rays, charged particles)

25<sup>th</sup> Meeting (5-6 June 2019)

BIPM, Sèvres

<b>Chair</b>	Dr Malcolm McEwen (NRC)
<b>CCRI President</b>	Dr Wynand Louw (NMISA)
<b>CCRI Executive Secretary</b>	Dr Steven Judge (BIPM)

#### Delegates

Mr Claus Andersen, DTU  
Dr Ulrike Ankerhold, PTB  
Dr Alexander Berlyand, VNIIFTRI  
Mr Hans Bjerke, NRPA  
Mr Jean-Marc Bordy, LNE-LNHB  
Dr Jacco de Pooter, VSL  
Dr Frank Delaunay, LNE-LNHB  
Dr Byoung-Chul Kim, KRISS  
Dr In Jung Kim, KRISS  
Dr Christian Kottler, METAS  
Dr Ernestos Mainegra-Hing (NRC)  
Ms Zakithi Msimang (NMISA)  
Ms Rebecca Nutbrown (NPL)  
Mr Chris Oliver (ARPANSA)  
Mr Fernando Ortega (CCHEN)  
Dr Linda Persson (SSM)  
Dr Massimo Pinto (ENEA-INMRI)  
Mr Hernán Rodríguez (CCHEN)  
Mr Paulo Henrique Gonçalves (LNMRI/IRD)  
Dr Annette Röttger (PTB)  
Mr Thorsten Sander (NPL)  
Mr Vladimir Sochor (CMI)  
Ing. Andreas Steurer (BEV)  
Dr Debbie van der Merwe (IAEA)  
Dr Anna Villevalde (VNIIM)  
Mr Kun Wang (NIM)  
Dr Jinjie Wu (NIM)  
Prof Jian Zhang (NIM)

#### Guest

Mr Kevin O'Hara (Sterigenics (Sotera Health LLC))

#### BIPM Staff

Dr David Burns  
Dr Claudiu Cojocaru (on secondment from NRC)  
Dr Cecilia Kessler  
Mr Philippe Roger

## 1. Welcome

Dr Malcolm McEwen (Chair – CCRI Section I) welcomed delegates to the meeting.

## 2. Confirmation of the Agenda and appointment of the Rapporteur

The agenda as presented was approved without changes. Claudiu Cojocaru (NRC Canada – on secondment to the BIPM) was invited to act as Rapporteur for the meeting and kindly agreed to take on the task. The attendees were reminded that the position of Rapporteur is a shared responsibility and that a volunteer would be sought for the 2021 meeting.

## 3. Progress reports

### 3.1 BIPM report to CCRI Section I

Cecilia Kessler presented the activities of the BIPM IR Department during the previous two years. The quality system has been reviewed and an external audit by an ENEA expert took place in 2018. On the radiation protection side there has been a continuous effort to comply with new French regulations; the regulations set strict time limits on the working life of sealed sources, and some older sources have had to be sent for disposal (as discussed below). Although, as an international body, the BIPM is not subject to French regulations, the BIPM's policy is to act in accordance with the regulations. The French authorities ASN visited the BIPM in 2019 to discuss the arrangements.

A report on the BIPM measuring conditions has been published.

Low-energy x-rays/mammography: Implementation of the recommendations of ICRU-90 has been completed. Anna Villevalde (on secondment at the BIPM from VNIIM) performed QA measurements at the reference distance and a new set of qualities were obtained at 1 m. In collaboration with Professor Pedro Andreo, calculations and measurement were performed in support of the update to TRS398. Five comparisons were performed in terms of air kerma between 2017-2019 as part of BIPM.RI(I)-K2 and BIPM.RI(I)-K7.

Medium-energy x-rays: Implementation of the recommendations of ICRU-90 has been completed. Quality assurance checks were performed for the new absorbed dose to water facility. The plan is to establish a new key comparison in terms of  $D_w$  and to launch a calibration service. In terms of air kerma, two key comparisons were performed: BIPM.RI(I)-K3 and BIPM.RI(I)-K9.

Co-60/Cs-137: Implementation of the recommendations of ICRU-90 has been completed, but the impact was small -  $D_w$  reduced by 0.10 %. A new reference Co-60 beam (Theratron) is being used and the older CIS-Bio irradiator has been removed. The BIPM's Cs-137 irradiator also had to be removed and an agreement has been reached with the IAEA to use the new Cs-137 irradiator at the IAEA Laboratory; the BIPM.RI(I)-K5 service will restart using the IAEA facility.

Key comparisons continued for BIPM.RI(I)-K1 and BIPM.RI(I)-K4.

High-energy x-rays: There is an agreement in place with the DOSEO platform in Saclay near Paris to use their Elekta Synergy linear accelerator that delivers beams of 6, 10 and 18 MV. The BIPM's work at DOSEO has included the characterization of the beams, improvement in beam monitoring, establishing the dose to graphite by measurements with the graphite calorimeter and calibrations of reference chambers. A project on the chamber responses in Elekta and Varian linac beams is underway involving a secondee from the NRC Canada,

taking advantage of the fact that at DOSEO there is also available a Varian TrueBeam linac. Two comparisons have taken place at the DOSEO facility.

HDR Ir-192 brachytherapy: Stability checks have been performed. One comparison in terms of air kerma rate for Ir-192 with VSL has taken place and the BIPM would like to know if other labs are interested in participating. Future comparisons are planned for 2020-2021.

Malcolm McEwan (NRC) asked about the 10-year limit on sealed sources in France and whether the source could be replaced. David Burns (BIPM) replied that it is possible to extend the working life to 15 years. The process will be started next year. Malcolm McEwan (NRC) went on to ask about whether the existing Co-60 source could be used for calorimetry – David Burns (BIPM) replied that the dose rate was already too low for calorimetry but would be suitable for chamber calibrations and comparisons for another 8 or 9 years. For calorimetry BIPM will need to move to the linac at DOSEO but there will be an increase in the uncertainty (acceptable but not recommended). The cost of Co-60 could be an issue.

There was a general consensus that most metrology laboratories purchase a replacement Co-60 source every 5-6 years. The meeting also agreed that it was important that the BIPM retained a Co-60 irradiation facility as it is the reference for many dosimetric quantities.

Malcolm McEwan (NRC) asked for more details on the BIPM agreement with the IAEA on the use of the IAEA's Cs-137 facility. Steven Judge (BIPM) replied that the BIPM is in contact with Debbie van der Merwe (Head of the Dosimetry and Medical Radiation Physics Section at the IAEA). Philippe Roger (BIPM) will develop a completely independent measuring system to be used at the IAEA facility. He will work with Ladislav Czap (IAEA) to characterize the beam. There are several details to resolve such as the time use/sharing of the beam and the arrangements for the transportation of instruments. Debbie van der Merwe (IAEA) added that the Cs-137 beam is not functioning yet but will be available towards the end of the year. It was also noted that some NMI's come to BIPM for several calibrations at one time which should be taken into account in the new arrangements. Malcolm McEwan (NRC) asked that the BIPM report on the new arrangements at the next meeting of the Section in 2021.

Malcolm McEwan (NRC) asked if sharing facilities in this way was for cost-savings. David Burns (BIPM) answered that the decision was not solely based on cost but rather to reduce the number of high activity sealed radioactive sources. No options are "zero cost".

Malcolm McEwan (NRC) asked about staffing levels in the department. David Burns (BIPM) explained that Dr Susanne Picard was working on the development of the KCDB and that the Ionizing Radiation Department was stretched as a result.

### **3.2 Report from the CCRI President**

Dr Wynand Louw informed delegates that a new CCRI President will be elected at the CIPM meeting in October 2019, as he has to step down to take on the role of CIPM President.

The structure of the CCRI was brought up for discussion including the need for the CIPM to approve membership of the sections. One advantage of following the rules applied to Working Groups was that there is more flexibility and members don't need to be appointed by the CIPM.

Discussions continued on the criteria for Membership of the CCRI. One proposed criterion was that for CCRI membership a country has to be a member of one of the three CCRI sections and contribute to the other two sections. A clarification is also needed on the definitions of member, observer and guest status for countries.

The arrangements for the present CCRI meeting was a trial run of holding the section meetings in parallel, and feedback will be sought on the new format.

### **3.3 Program of Work 2020-2023 of the Ionizing Radiation Department**

Steven Judge (BIPM) presented a talk on the next BIPM work program. The main external factors taken into account for dosimetry and radioactivity were a change from Co-60 based treatments to linac radiotherapy, new types of therapies and more stringent regulations on the use of sealed sources. One way to move forward is to use shared facilities and get involved in joint projects. The BIPM will re-establish the Cs-137 service at the IAEA facility.

There is also a project to explore the long-term needs, such as comparison exercises for standards for proton and heavy ion therapy. The BIPM is also very active in capacity building and knowledge transfer through programs of secondments (directed mostly towards more junior scientists) and sabbaticals (mostly for more senior scientists). The BIPM aims to be responsive to changing needs.

There were questions about the advantages / disadvantages of sharing resources. The use of the DOSEO linac is one example and in the future access to a proton facility may be needed; the investment needed for such facilities at the BIPM is prohibitive.

The topic of the need to respond to rapidly changing requirements was discussed. The BIPM seeks feedback at meetings (such as the CCRI meetings), input from NMIs and from workshops. The BIPM's work program is reviewed and approved at the CGPM every four years but there remains some flexibility to respond to changing needs within the program.

The meeting noted that the human resources at the BIPM are spread very thin and that the use of external facilities will involve more travel for the BIPM staff. The question was asked about the possibility of hiring additional staff. Steven Judge replied that the funding for the BIPM is decided at the CGPM; it has been flat for 8 years but a small increase was obtained in 2018. No immediate additional hiring is possible but secondees and sabbaticals are encouraged. The BIPM is also looking for close partnerships with NMIs (successful examples include working with the NRC and the IAEA). Delegates emphasized that the use of secondees/sabbaticals are short-term fixes only and will not help BIPM to maintain capabilities into the long term, permanent members of staff are needed.

On the brachytherapy side a new source will be bought in order to continue monitoring the BIPM chamber for the next 10 years. The service will be advertised to encourage higher utilization.

Questions were asked about the operation of the quality system: Steven Judge explained that the BIPM follows the requirements of ISO17025, there is a programme of internal audits and external audits, and that there is a Quality Manager.

### **3.4 CCRI RMO Working Group report**

Dr Ulrike Ankerhold (PTB) reported back from the RMO WG meeting held earlier in the week. One issue was that Sections II and III were considering recommending an increase in the period of validity of comparisons from ten to fifteen years (and even maybe up to twenty years in exceptional circumstances)<sup>1</sup>. The increase to fifteen years had been discussed at the 2017 CCRI Section I meeting but no firm conclusion had been reached. A risk assessment was needed.

The topic was discussed at length and the consensus was that the 10-year cycle remains a good compromise between ensuring the quality of measurements and workload on metrology institutes. An option to extend this to 15 years in exceptional circumstances should remain, to allow some flexibility and take into account the workload of the BIPM services.

Clarification of the reasoning behind the proposed changes for the service categories was requested. There had been an RMO WG meeting in March 2018 on how to reduce the number of CMCs. In the current working version, dose and dose rate are covered under one entry but questions remained about how to deal with materials and sources to decrease the number of CMCs. Delegates argued that any changes should have as the final focus helping the client community and considered that the new version simply presented the same information in a different way. It was noted that many directors of NMIs ask for a reduction in the number of CMCs to reduce the administrative effort, but delegates considered that the priority was clarity for the customers.

### **3.5 Report on the CCRI(I) Key Comparison Working Group meeting**

Dr Malcolm McEwen reported on the KCWG meeting which had taken place earlier in the week. The KCWG had reviewed the activities of the KCWG and had agreed that:

- The KCWG would seek to improve the review process for reports by assigning named reviewers for each report and would take an active role in organizing the work
- The link between key comparisons and support for CMCs would be clarified (“how far the light shines” statements) with the aim of reducing the workload
- Co-ordinating RMO comparisons with the BIPM services would be addressed
- The KCWG would also act as a technical advice forum

The creation of a joint Section I / Section II working group on molecular radiotherapy was discussed. Some laboratories reported that they are working in this field and that there was interest in a working group on this topic. A joint working group will therefore be proposed by the Chair of the Section.

## **4. CIPM MRA Issues**

### **4.1 JCRB and KCDB Report**

The JCRB Executive Secretary, Sten Bergstrand (BIPM), gave an overview of the issues being addressed by the JCRB. There was a reminder to TC and WG chairs to confirm at the beginning of an inter-RMO review that the quality management system evidence supports the CMC set (CIPM MRA-D-04). Sten emphasized that his colleagues and he were there to help – there are often precedents in different fields that can provide solutions to issues.

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<sup>1</sup> The decision on the periods of validity of the comparisons is recorded in the CCRI minutes and remains 10 years for Sections I and III.

The KCDB Coordinator, Susanne Picard, presented the new version 2.0 of the KCBB platform that will be on later in 2019. It has a new interface and there will be user accounts for submissions of CMCs. The guidance documents CIPM MRA D04 and D05 remain valid.

## 4.2 Comparisons

### 4.2.1 BIPM and CCRI(I) key comparisons status.

The BIPM comparisons are continuing to operate following the schedule (see the BIPM report above). There is a proposal for a new key comparison for high dose rates. The comparison (CCRI(I)-S(3)) will use alanine as a transfer dosimeter. Calibration capability requires a gamma-cell irradiator. It will be linked to K4 by BIPM irradiating alanine dosimeters at their facility irradiations at the 1 kGy level. The following labs will participate: CMI, ENEA-INMRI, LNMRI, NIM, NIST, NMIJ, NPL, RDTU and VNIIFTRI. NPL and NIST will provide the alanine dosimeters and the NRC will act as the organizing laboratory. The protocol will be available soon.

The possibility of new key comparisons was discussed. There was some interest in a comparison for high-energy electron beams but only a few laboratories have primary standards.

It was pointed out that for small field dosimetry it is important to define the reference conditions for the comparison (e.g. size, shape). ARPANSA has worked on this topic.

Opportunities to improve the efficiency of comparisons were discussed. It was noted that in terms of staff effort in this field it was difficult to determine whether batch or bilateral comparisons were more efficient. Bilateral comparisons were thorough as there could be detailed discussions of the results. In EUROMET, comparisons are often an integral part of the research project.

The 'ideal' number of participants in a comparison was discussed. The conclusion was that it depends on the type of comparison; some large scale comparisons with 40 participants have been run very successfully.

### 4.2.2 Regional key and supplementary comparisons status

The RMOs presented a summary of the regional comparisons that took place in the last two years:

AFRIMETS: No comparisons have taken place.

COOMET: There have been two comparisons: a bilateral PTB-Cuba comparison and air kerma measurements. A comparison of air kerma in x-rays is planned including Belarus and 8 other countries.

EUROMET: There are eight ongoing comparisons including radiation protection dosimetry and beta dosimetry. Portugal, Spain and Bosnia-Herzegovina are participating.

SIM: K1 and K4 comparisons are scheduled to start soon (10 years since the previous comparisons of this type) and a radiation protection comparison will start next year

APMP: A total of 36 comparisons have taken place.

### **4.3 Impact of adoption on ISO17025:2017**

Delegates reported on progress on adopting the new version of ISO17025 and confirmed that the transition was not difficult. A gap analysis at the start of the transition had proven useful. Peer review of the revised quality systems was the next step.

## **5. Strategic planning 2018-2028**

### **5.1 Short term (2018-2020) and medium term (2020-2023)**

In general, each NMI has their own strategic plan which can be shared with the CCRI Section I to guide the Section strategy (laboratory reports are available on the BIPM website).

Implementation of the new key data published in ICRU-90 is a key action in the short term plan. NMIs presented the status of their implementation. There is a report in Metrologia by David Burns and Cecilia Kessler on how to implement ICRU-90. The NRC and ARPANSA performed their own calculations and obtained values different by 0.05 % from those of the BIPM. NMIs that carry out their own calculations were invited to submit their results to David Burns and Cecilia Kessler, and they will prepare a summary of the changes between new and old values.

### **5.2 Status of CCRI strategic plan**

#### **5.2.1 Photon dosimetry**

One action from the plan had been completed: Anna Villevalde from VNIIM was on secondment at the BIPM and had performed measurements on beam characterization for low-energy x-rays. No major differences with the old data have been observed but the KQ correction factor was affected. The BIPM had wanted to do this work for some time, and the support from the VNIIM was gratefully acknowledged.

LNHB outlined the industrial demand for a standard at 600 kV for testing detectors used for radiation protection.

In the field of brachytherapy, delegates reported on developments on graphite and water calorimeters, and on the development of primary standards for LDR. The PTB reported on electronic brachytherapy devices under the EMPIR European project. The NIST has already a primary standard for electronic brachytherapy so it was recommended this was included in the project.

The ENEA has access to the synchrotron beam facility in Trieste to develop primary standards based on air kerma for low-energy photons (8 kV to 35 kV) as well as perform fundamental measurements such as stopping powers.

Dr Annette Röttger (PTB) gave a presentation on the EMPIR project concerned with radiation protection metrology. In Germany, all radiation protection devices are covered by a testing procedure defined by the German authorities under the Measurements and Verification Act, but the rules are different in different countries. New operational quantities have been proposed by the ICRU for radiation protection but there has been feedback from the user communities about difficulties in implementing the new quantities.

Kevin O'Hara from Stergenics gave a presentation on radiation processing for sterilizing medical devices and for food processing. There will be a workshop on radiation processing in June 2020. The industry is concerned that there are very few facilities at NMIs for calibrations at very high doses (4-20 kGy). NIST is replacing the gamma-cell 220.

A project is underway at the BIPM in collaboration with the NRC, DTU and LNHB to compare the output from Elekta and Varian linacs. Preliminary work carried out by ARPANSA suggests a possible difference of up to 0.3 % in KQ for low energies. Ionometric and calorimetric measurements are in progress using the DOSEO platform at Saclay in France and at the DTU in Denmark.

VSL presented on work in MR linacs using water calorimetry for studying the correction factor due to the presence of the B magnetic field for two chambers in both directional orientations relative to the B field. Presentations were also given by ENEA, LNHB, NRC and NIST.

### 5.2.2 Charged particle dosimetry

#### **Electron/beta dosimetry**

Malcolm McEwen reported that there has been no progress on calculations of KQs in electron beams (only MV calculations have been performed). At present, the user community relies on Co-60 calibrations. NRC is launching a service this year but it does not expect much demand.

Anna Villevalde (VNIIM) presented work on a beta secondary standard manufactured in Belarus (similar to the PTB BSS device). A comparison with the PTB would be welcomed. The VNIIM plans to participate in the EURAMET comparison.

#### **Heavy ions and other charged particles**

The NPL, PTB, NMIJ, VNIITRI, KRISS and NIM have worked on the development of water and graphite calorimeter systems for use in protons and heavy ion beams. With more countries having proton and heavy ions facilities, a comparison might be needed soon. It was suggested that in 2021 the community should think about the concept/procedure for a comparison.

There was a short discussion on dosimetry for radiobiology and the main topics covered were:

- Using Co-60 as a source for dosimetry
- The use of 2.5 mm alanine dosimeters
- Opportunities to use a micro-beam facility to study DNA breaks
- Applications of fluorescence imaging

## **6. Input from RMOs: AFRIMETS, APMP, COOMET, EURAMET, SIM**

AFRIMETS noted that it was important for radiation dosimetry to retain close links to the user communities to ensure continued relevance. The establishment of quality management systems had also been an issue in the region.

APMP report that Indonesia had joined the RMO. Workshops had been held in New Delhi (2017) and in Singapore (2018). A new working group on uncertainty evaluation had been established. The region had published 821 CMCs. Some funding had been made available to support collaborative research projects.

COOMET had nothing additional to report.

EURAMET reported that the TC-IR had met in Slovenia in 2019. Moldova had joined both EURAMET and COOMET. There were twelve research projects in progress under the EMPIR scheme. A training course on



organizing comparison exercises was planned for October 2019 at the BIPM. Digitization was a key area of development in the field.

Moldova is a new member of EURAMET and COOMET.

### **7. Input from stakeholders.**

Dr Debbie van der Merwe reported on activities at the IAEA. The IDOS 2019 symposium will take place in June 2019. A new Varian TrueBeam linac is being installed at the IAEA site.

### **8. Publications**

Reports from NMIs/DIs will be made available on the BIPM website.

### **9. CCRI(I) membership changes**

The DTU has become a member of CCRI(I).

It was noted that CCRI Sections now operate following the rules of Working Groups.

### **10. Date of next meeting**

The next meeting of the CCRI Section I will be in 2021, date to be decided.